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AUTHOR Char, Cynthia A.
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ABSTRACT

This paper offers historical, present, and futuristic perspectives on the role of interactive technology in the lives of young children. In the early 1980s, debate tended to center on the question, "Are computers good for young children?" At the time, educational software consisted almost exclusively of animated drill and practice programs. Now, advances in software technology have resulted in more exploratory, open-ended software programs and tools and better guidelines for evaluating and designing developmentally appropriate software with features intended for 3- to 6-year-olds. In the future, researchers, designers and educators should assume a more active role in determining how technology might enhance young children's learning and development. Interactive technologies might offer children powerful tools and environments for: (1) creating multimedia compositions; (2) enhancing intuitive knowledge and decision-making processes; (3) extending mathematical exploration and problem solving; and (4) supporting social interaction, collaboration, and perspective. Several aspects of young children's use of computers are addressed that illustrate the ways in which technical developments in computer hardware could broaden our conceptions of young children's interactions with technology. A list of 21 references is included. (BC)

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Interactive Technology and the Young Child

Insights from Research and Design

Cynthia A. Char

Report No. 90-2

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Interactive Technology and the Young Child

Insights from Research and Design

Cynthia A. Char

This paper offers both historical and futuristic perspectives on the role of interactive technology in the lives of young children. Following an overview of the major developments since the early 1980s, when interactive media were first introduced into homes and schools, the paper suggests important directions for the future. Discussed are ways interactive technologies might offer children powerful tools and environments for (1) creating multimedia compositions; (2) enhancing intuitive knowledge and decision-making processes; (3) extending mathematical exploration and problem solving; and (4) supporting social interaction, collaboration, and perspective taking. Several design examples illustrate how technical developments in computer hardware might broaden our conception of how young children can interact with technology.

Budding creativity, self-expression, and experimentation make early childhood an exciting time. Young children are actively exploring the world around them—objects, people, sounds, and tactile sensations. Whether it be at the water table, paint easel, or block corner at school, or looking at a storybook or cooking with a parent at home, children are discovering and learning much about the physical and social world through play, experimentation, and interactions with other children and adults.

What role might electronic media play in the young child's world?

The Past

When interactive technology products first became available to homes and schools in the early 1980s, the debate in the field tended to focus on the question, "Are computers good for young children?" While some educators optimistically regarded computers as the long-awaited panacea for many problems in education, a number of early childhood educators voiced concern that computers were inappropriate and possibly harmful to young children.

For example, some (e.g., Barnes and Hill, 1983; Cuffaro, 1984; Elkind, 1987) argued that the "stuff" that computers offer (e.g., colorful pictures, sound effects, and flashing and moving objects on a flat screen) is in some fundamental way not "real" or "of this world," in the way crayons, blocks, paint, and paper are. Thus, the argument went, computers can provide only indirect, inferior experiences of the world, making their educational value for young children highly questionable at best. At the time, educational software for young children consisted almost exclusively of animated workbooks, or "drill and practice" activities cloaked as entertainment in which a child's correct response might result in letters or numbers blinking, brightening, or becoming animated in some way.

The Present

Both the early childhood and software fields have made clear advances since then in their knowledge, experience, and sophistication. As Clements (1987) has said, "We now know that computers are neither panacean nor pernicious," and that what matters is "the quality of the software, the amount of time it is used, and the way in which it is used."

In addition to structured programs reminiscent of earlier products, there are now a growing number of more exploratory, open-ended software programs, as well as software tools such as paint packages and talking word processors designed especially for young children. Researchers have shown that computer software, particularly the more exploratory and tool-like environments, can encourage young children's problem solving, language development, creativity, collaboration, and communication (Char, 1989; Clements, 1987; Quinsaat & Kurland, 1989; Wright & Samaras, 1986; Wright, Shade, Thouvenelle, & Davidson, 1989). Some researchers and organizations (e.g., Haugland & Shade, 1988; High/Scope Educational Research Foundation, 1988) have also gone further to lay out guidelines for evaluating and designing software that would be developmentally appropriate for young children (age three to six). Features that have been listed include

- easy controls such as a mouse or single key;
- one-level picture menus with simple point-and-click choices that make it easy for children to learn and use programs independently;
- judicious use of colors and sounds to make programs inviting but not overly stimulating; and
- appropriate early childhood content, arranged to provide choices and room for creativity, and to accommodate a range of skills (High/Scope Educational Research Foundation, 1988).

Building upon the work of educational researchers and practitioners, groups such as the National Association for the Education of Young Children (NAEYC) have acknowledged that computers can enhance young children's learning and collaborative experiences with peers, and have issued guidelines for selecting software and using computers in the classroom.

The Future

Now that we have entered the 1990s, researchers, designers, and educators should no longer be content merely to respond to newly emerging technologies, but should assume a more active role in determining how technology might truly enhance young children's learning and development. To borrow a phrase from the French aviator and writer Antoine de Saint-Exupery, "Our task is not to foresee the future, but to enable it."

Important directions for future work, some of them drawing upon innovative work already initiated, include discovering ways that interactive technologies can offer children a variety of powerful tools and environments for

- creating multimedia compositions rich

with sounds, images and words;

- making intuitive knowledge and decision-making processes explicit; and
- extending mathematical exploration and problem solving.

Technical developments in computer hardware also open up new creative opportunities for young children to interact with technology in ways that can enhance their learning. With all of these software and technical developments, however, teachers and parents continue to play an important role in the young child's learning with technology. Each of these aspects of young children's use of computers is addressed below.

Computers and Multimedia Systems as Symbolic Machines

As Sheingold (1986) contends, some of the computer's powerful educational potential derives from the fact that it *is* a symbolic machine, with which young children can represent and manipulate different symbol systems (language, mathematics, and music), and create various symbolic products (stories, mathematical expressions, and songs). What might multimedia systems—as integrated and responsive video, audio, and text environments—mean for young children's learning?

How might children's multimedia journals, for example, encourage emerging literacy skills? Children's storytelling might begin with artwork, either created directly on the computer or drawn with crayons and paper and scanned into the system. A child could then narrate her story into the system using a microphone and play back the soundtrack, modifying it until it met her satisfaction. Written text might be added to the system, by either the teacher or the child, and linked to the spoken words so that clicking a mouse on an individual word on the screen would call up the child's own voice. Such "story files" could be stored and shared with other classmates and parents, and even shipped to a proud grandparent via a telecommunications link.

Less elaborate high-tech options will soon be made available in American homes. For example, in collaboration with American Interactive Media, I have designed for a new digital video system called CD-I (Compact Disc Interactive) two early reading interactive video environments intended for use at home by four- to six-year olds. Each of the discs features a number of "interactive songs" that allow children to experiment with various components of a song's lyrics. Through that process, children can explore such language patterns as onomatopoeia and rhyming.

What is the potential of such systems to enhance children's expression of ideas; their understanding of the relationships between visual images and words and between spoken and written language; and the interplay of sounds, rhythms, and meanings of words inherent in songs? What are their limitations? Might the images and sounds provided by the system be so seductive as to stifle children's interest in creating their own pictures and sounds? Might children use such built-in graphic and auditory components "just because they're there," rather than in response to their own creative urges? While there is a growing body of research on how HyperCard (software that permits multimedia composition) is used by upper elementary and high school students (e.g., Nichols, 1990; Tierney, 1989), a rich area for research and design lies in the potential of multimedia systems for supporting young children's expression of stories and ideas.

Making Intuitive Knowledge Explicit

Based on research with elementary school children who created simple computer programs to explore the rhythmic properties of music, Bamberger (1983) concluded, "The computer, rather than being a super brain, teaching us with its consistent logical 'thinking,' is instead a fantasy world which, like a hall of mirrors, reflects back to us images of our common sense ways of making things and making sense." That is, she saw the computer as a medium that can help children discover and reflect on what they already know intuitively.

Forman (1984) also contends that the computer can help young children to distance themselves from objects, causing them to pause and reflect upon experiences, decisions, and knowledge. In his study, Forman observed pairs of preschool children engaging in dramatic play either with real dolls (Smurf figures) or with their electronic counterparts, Smurf characters in an

electronic puppet theater. The findings from the study were intriguing. Because the computer program offered explicit choice points and required specific actions for selecting scenes and furniture, children using the program were more likely to verbalize desires in the form of a proposed plan (e.g., "Let's go to the kitchen" or "Let's get a bed, one for you and one for me"). In contrast, children's dramatic play with toys in a real doll house prompted less discussion and communication of their decisions. Thus, computer software can encourage children to articulate decisions and plans and lead to greater verbal and social interaction with others.

Forman also identifies the potential of the computer's record and replay function, what he calls "playable replayables":

> Children might re-enact a routine recently performed in the doll house, but at no point could they watch that action happen again, exactly as before, without their hands being in the scene. . . . Video replay can increase the distance between self and object. . . . This type of distance between the present actions of the self and the video clip as a future object is essentially a new level of reflection and planning. . . . With playable replayables, children will be able to do more than learn by doing, they will learn by reflecting on what they have done.

Forman (1985) does caution that we cannot assume that replay is the same as feedback, and he describes four levels of understanding. At the first level, young children have difficulty simply figuring out which of two moving objects is under their own control, or "which one is mine." At level two, around age three and a half, children can quickly test who belongs to whom, in the form of "meta-play" to see if a button push results in a Smurf jumping. However, they still view the replay as an interruption (the machine is taking over), rather than as something they recognize as their own work. It is only at the later stages that children can begin to "see the present as the future's past," and fathom that "I will do something now that I will look at later that will remind me of the thing that I am now doing."

Clearly, another fruitful area for research and design is to examine how interactive technology might afford young children a new tool and environment in which to increase their reflectivity; articulation of interests, plans, and decisions; and meta-awareness of phenomena.

Math Manipulatives and the Computer: A Powerful Partnership

Perl (1990) describes various models for pairing math manipulatives (real three-dimensional objects used for mathematical exploration) with complementary software. She offers four different models: mirroring, modeling, manipulating, and managing.

Several projects in the Center for Learning Technology at Education Development Center (EDC) have been exploring the potential of on-screen manipulatives: computer graphic objects that serve as a new form of math manipulative for young children. For example, in *Exploring Measurement, Time, and Money—Level I*, mathematics software for kindergarten through grade two, developed by EDC and published by IBM, some of the software activities offer an open-ended environment for children's exploration, in which they receive responsive feedback, in the form of digitized speech, for their self-initiated creations. For example, children can set the hands on a clock to whatever position they wish and hear the time, or they can pull up coins in any combination they choose and hear the total value of the set.

In more structured problem activities, animation and software feedback in the form of digitized speech provide children with visual and auditory modeling of problem strategies. For example, in problems that call for adding up the value of a set of coins, the software can demonstrate to young children the advantages of arranging like coins together, from larger to smaller denominations, and highlight coins in the array along with a verbal counting-on strategy. (For example, the screen shows dime, dime, nickel, penny, penny, and the speech says, "10, 20, 25, 26, 27 cents.") Thus, digitized speech can do more than simply give directions for an activity or indicate whether a child's answer was correct or incorrect; it can actually model mathematical strategies.

Some of our research has begun to consider what might be optimal ways to integrate

children's work with real hands-on manipulatives and their on-screen counterparts, and how teachers might best orchestrate children's independent efforts and work in pairs with such materials, along with larger group discussions, activities, and demonstrations. Much work still needs to be done in this area.

Moving Beyond the Two-dimensional World of Technology

Cuffaro justifiably pointed out in 1984 that one of the major limitations of the computer is that it only presents children with a flat, two-dimensional world. That represents a considerable constraint given the developmental needs of young children who are actively exploring the world, using large motor movements, moving through space, and positioning themselves and objects in relation to other people and objects in a rich three-dimensional world.

While the limit of technology to two dimensions is still the norm in today's schools and homes, technical advances can overcome this constraint. Forman (1988, 1989) has proposed some intriguing designs that allow children to explore relationships such as movement, space, and speed in three-dimensional space. Unlike *Lego-Logo*, which takes a two-dimensional program on the screen (a Logo computer program created through keyboard entry) and translates it into a three-dimensional event (e.g., a Lego car that moves about with light and touch sensors to explore a space), Forman's designs feature three-dimensional "dual input-output devices."

For example, Forman describes a programmable mannequin which children manipulate at its joints and limbs to simulate walking. Later, by hitting a replay button, the child can watch the robotic motors animate the doll through the same sequence the child has just "programmed." Or, in his design for "trainable trains," he describes a child moving one or two cars, in turn, over an input board laid flat on a table with a matrix of microswitches that relay information to the computer. The child can replay that programmed movement to explore relationships in space, speed, and distance.

Similarly, several years ago, working in collaboration with an industrial design firm, I was asked to design the ideal hardware environment for kindergarten through grade three classrooms. Rather than working from the top down, starting with input devices designed for adults and then "child-proofing" them through hardware modification and software design, we adopted an approach that began with the young child and the child's-eye view of the classroom. In particular, we strove to focus not solely on the cognitive or intellectual dimensions, but to pay special attention to the physical facets of the young child's world and capitalize on children's high level of energy and use of large body movements.

A data glove—a glove with electronic probes that tracks not only where the user's hand is in three-dimensional space, but also whether that hand is open or closed—allows the user literally to pick up and place software objects in space, with the "wave" of a hand. Thus, one possibility is to create a data glove device for a small child's hand.

However, all who know small children would agree that children do not discover the world only with their hands and express themselves only through words, but often throw their whole bodies into action. Thus, one of the products we designed was a "gestural jumpsuit" for children (figure 1). Based on prototypes used for tracking

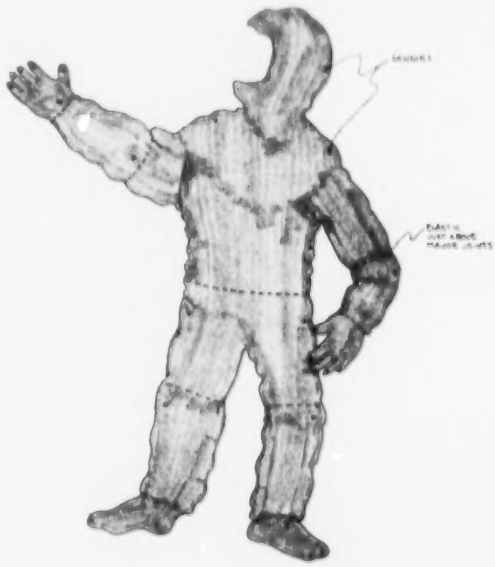

Figure 1

Figure 2

choreography and sports movements, we envisioned children wearing a gestural jumpsuit that might "drive" a number of software and video applications, such as an art or story animation package based on wire-frame animation (figure 2). Using such a system, a child could emulate the movements of different animals and see the resulting graphics of a hopping frog, jumping kangaroo, soaring hawk, or slithery snake!

Another product design we created was the "electronic mat." Designed as a dual input-output device, it is analogous to a touch screen, but much larger. It would lie on the floor and be able to drive a number of group activities in art, movement, music, and mathematics. For instance, children could slide across the mat, creating a visual trace behind them for collaborative artwork (figure 3). Or, used with music software, different areas of the mat, or different children, could be designated as different instruments, and children could form an orchestral ensemble by marching in place, skipping, or hopping.

Technology for Groups: Social Interaction and Collaboration

The electronic mat also suggests another important dimension for future consideration—how technology might support the social dynamics of young children's interactions, their interest in other children and in cooperative work and play.

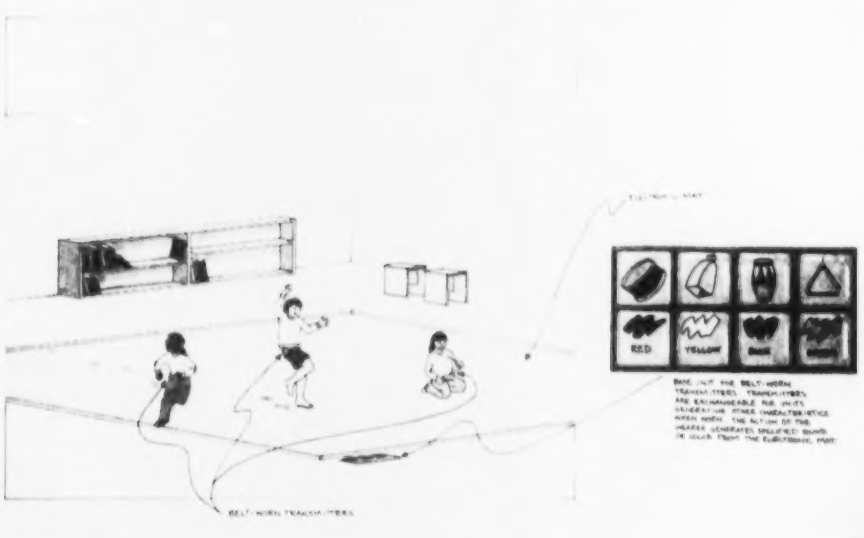

Figure 3

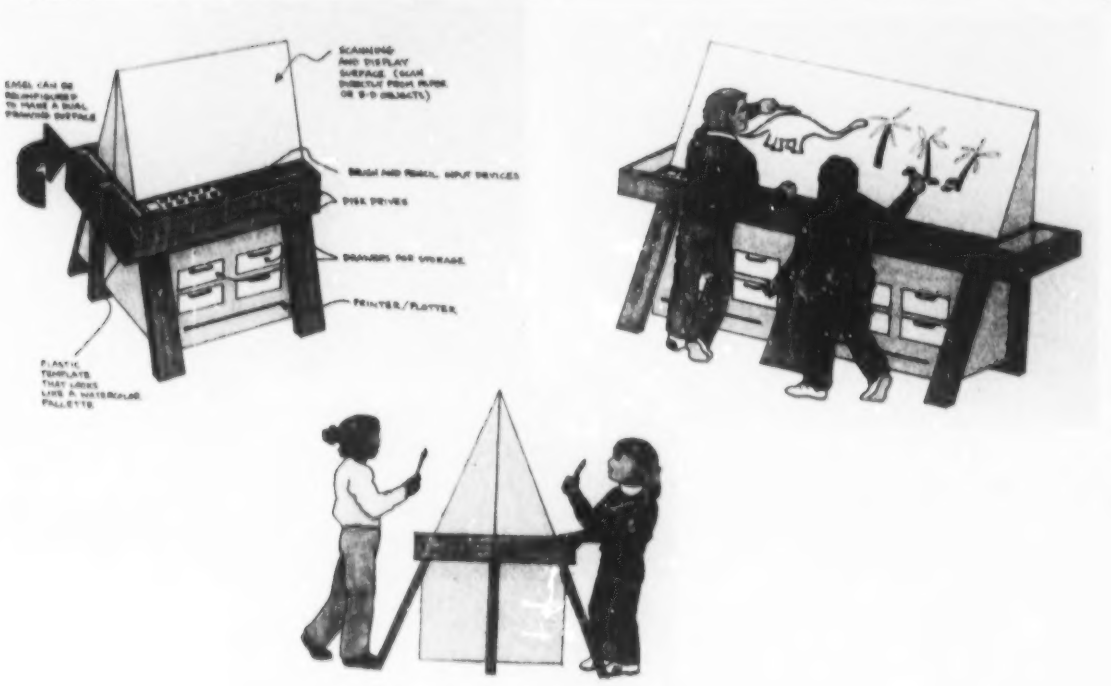

Figure 4

With this dimension in mind, we designed a third product called the "art cart" (figure 4), which is a reconfigurable touch screen easel for collaborative art projects. The hardware would resemble a two-sided easel, but would be networked and could be reconfigured for varying levels of collaboration. It could, for instance, allow children to share and exchange graphic images from their individual pictures or to swing the easels around to create a joint picture on a single, larger easel plane.

In addition to combinations of hardware and software to support children's collaborative activities, software alone can be designed specifically to support social interaction. For example, software can do more than simply referee turn taking; it can create different role-playing environments for children. For example, the *Sticker Store* program in *Exploring Measurement, Time, and Money* allows two children to assume the role of buyer and storekeeper, in order to learn about the distinct, but complementary, tasks of producing an amount of money to make a purchase and making change for customers.

Media can also be designed to address not only role playing, but perspective taking. In a study by Miyazaki (1988), preschoolers were shown two versions of a picture book in which the same story was written and illustrated from the point of view of two different characters—a boy and a frog. Results from this study, and others Miyazaki and colleagues conducted with older children, indicate that children do "throw" their imaginary selves into a central character and gain a deeper understanding of that character's behavior and feelings, while still maintaining satisfactory knowledge of the other character. Thus, interactive video and software might also offer some interesting opportunities for children to explore point of view, perspective taking, and empathy for others by "opening their eyes, through the eyes of another."

The Role of Teachers and Parents

It is clear that the full educational potential of technology for children can only be achieved if teachers and parents are involved as central players in the "system." As with any educational material or resource, interactive software and video work best when properly introduced, embedded within a meaningful context, monitored appropriately, and extended through discussions with children and related hands-on activities, books, and other experiences. Providing a well-written software user guide is only a

beginning. It is essential that we address the larger, more complex issues of teacher training, support, and professional development, and how best to utilize the expertise and services of libraries, museums, and other community-based organizations to involve parents more fully in their children's learning experiences.

Summary and Conclusion

In summary, we have come a long way in the past ten years, regarding our knowledge, experience, and thoughts on the educational potential of interactive technology for young children's development. Granted, there still remain serious hurdles to making some of these visions a reality, including the limited resources for early childhood education, the high costs of technology, and formidable challenges for teacher training and support. However, I believe that if we simply dwell on these constraints, we may never grasp the full potential and value of young children's technology-based learning.

It is critical for us to continue to ask the hard, probing questions and maintain a level of healthy skepticism, yet at the same time utilize our intellectual energy and creativity to push the limits of the machines and of the hardware and publishing industries. It is only through our best, collective research and design efforts that interactive technology will offer valuable opportunities for young children's learning and development.

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